On-site Inspection

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Outline

- Physical consequences of an underground nuclear explosion
- Signatures
- OSI purposes & techniques
- Challenges
- Responses from the scientific community
What is an Underground Nuclear test?
DUE TO THE SPECIFIC NATURE OF UNDERGROUND TESTS:

• Containment requires:
  – Deep emplacement
  – Use of metallic (ferrous) elements

• Diagnostics
  – Remote equipment and control point
  – Numerous cables

• Formation of signatures (Geo+RN)
  – Engineering activities
  – Explosion impact
  – RN release
Signatures of an UNE

- Detectable anomalies
  - Visual
  - Magnetic field
  - Gravitation field
  - Electrical conductivity
  - Reflection/refraction of EM signals
  - Seismicity and response to seismic signal
  - Radionuclides, noble gases
An OSI clarifies whether an underground test has occurred

- Position finding
- Visual observation
- Photography and multi-spectral imaging including infrared
- Measurement of levels of radioactivity above, at and below the surface, using gamma radiation monitoring
- Environmental sampling
- Passive seismology aimed at monitoring aftershocks
- Active seismic surveys
- Magnetic field mapping
- Gravitational field mapping
- Ground penetrating radar
- Electrical conductivity measurements
- Drilling

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Challenges

Complex scenario: attractive challenge for the scientific community: a lot of sci & tech behind OSI !!!

Several institutions have responded to the ISS call for papers, presenting high quality & original scientific contributions on the various fields of interest of an OSI. Some papers went even beyond the expectations, covering activities not mentioned in the Treaty, but still possible as NTM
Application of new analytical methods, numerical modeling
Detection of ionospheric traces of an UNE
Analyses and interpretation of aftershock data for event location
Passive seismic monitoring during an OSI
New estimates of ground level RN distribution for UNE leakage
Noble gas detection during an OSI
Gamma detection during and over-flight
Ideas to enhance realism of an OSI field exercise
Alternative approaches to establishing effective OSI’s
Use of satellite imagery

70% of the contributions were int. collaborative projects
Magnetic field modeling

Vertical geometry

\[ M = 100 \text{ A/m} \]

\[ I = 60 \text{ deg} \quad D = 0 \text{ deg} \]
Magnetic field modeling

I = 60° ; D = 0°  multilevel

[Diagram showing magnetic field at different altitudes with northing and easting meters]
Ground-based potential fields observations
Magnetic field modeling

\[ h = 2m \quad \text{D2V} \quad \text{max ampl.} = -800; 2700 \text{ nT/m}^2 \]
Gravity field modeling

Cavity: depth = 300 m radius = 40 m; \(d = 2.6 \text{ g/cm}^3\)
Gravity field modeling

Cavity: depth = 300 m radius = 40 m; d = 2.6 g/cm³

Negative anomaly
Interactive parametric gravity field modeling
From theory to practice

Field applications
From theory to practice

Field applications
From theory to practice

Field applications
Factors affecting the measurements

- Magnetospheric activity
- Altitude changes (terrain clearance)
- Local geology
- Cultural noise
- Noisy aircraft
- Inappropriate data collection/reduction

Only experienced people can obtain reliable results !!!!
Some conclusions and outcomes

- The broad participation without direct funding demonstrated a huge interest from the international scientific community
- There is a recognized need to share experience and expertise in the OSI field of activities
- ISS-09 has represented a key outreach component of the CTBT
- The valuable network established by ISS could continue in order to make an assessment, independent of the CTBTO, of the verification capabilities in the future